

DYNAMIC SOCIAL PERCEPTION IN ADULTS WITH AUTISM SPECTRUM DISORDERS

by

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### **Abstract**

Autism spectrum disorder (ASD) is a neurological condition that is typically diagnosed by the age of three-years-old. ASD can have a profound life-long impact on social perception, the maintenance of relationships, and communication abilities (Marshall et al., 2008). These impairments have been associated with issues with Theory of Mind (ToM), perspective taking, and executive dysfunction, as well as structural brain differences when compared to neurotypical adults. The ToM account is most important for our research question, and it states that individuals with autism are often unable to attribute mental states to themselves and/or others. This deficit is apparent through a failure to take other people's mental states into account (Frith, 1989). While many studies, such as Whyte and Nelson (2015), have described the effects of ASD on social perception in children, there is a lack of research involving adults with ASD. Additionally, there is a need for assessment and training tools that encompass ecologically valid, dynamic stimuli. A video inventory (Relational Inference in Social Communication or RISC) to test the perception of social intentions such as sarcasm, teasing, and prosocial lies allows for the investigation of interpersonal communication in both neurotypical adults and clinical populations. The current study used a subset of RISC videos to examine how adults with ASD and neurotypical adults understand nonliteral language and social intentions. We analyzed how individual differences in empathy and perspective taking influence the way adults with ASD evaluate social intentions using a set of standard questionnaires. We had a small sample size of only two participants that allowed for descriptive analysis of data. As expected, those with ASD showed a deficit in recognizing the speaker's intention, especially with negative intentions. The empathy scores demonstrated that those with ASD have more difficulty understanding the emotions of others (cognitive empathy) rather than sharing the emotion (affective empathy).

## **Dynamic Social Perception in Adults with Autism Spectrum Disorders**

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### **Autism Spectrum Disorder (ASD)**

Autism spectrum disorders (ASD) describe a range of neurological disorders that are typically diagnosed in the early years of life. Where an individual falls on the continuum is based on many factors related to cognitive processes and comprehension of the environment (Lawson, 2001). The core deficiencies of ASD entail difficulties with perspective taking, social interaction, and communication (Marshall et al., 2008). Those with ASD also tend to show deficits in social, behavioral, and sensory areas, such as unique interests, repetition in behavior, and uncomfortable social interaction (Lord et al., 2020). This influences their quality of life and maintenance of social relationships.

Though the exact cause is unknown, researchers have drawn a connection between ASD cases and genetic factors, as well as environmental elements. ASD seems to be one of the most heritable disorders, with siblings of those with ASD being fifty percent more likely to receive a diagnosis (Frith & Happe, 2005; Haroon, 2019). Anatomical brain differences in those with ASD have been difficult to narrow down. The most common finding is an over or under abundance of connectivity within the brain (Frith & Happe, 2005). The environmental components seem to directly connect to genetic factors; for example, some dietary choices may impact how the brain

develops (Frith & Happe, 2005). Epigenetics, genetics, and environmental factors all combine to form development of ASD. Independent of the cause, ASD seems to be determined by the impairments of the brain (Haroon, 2019), especially brain connectivity and neural oscillations (Ventola et al., 2007).

Though the prevalence of ASD does not seem to be high, only one percent worldwide, it is more common in affluent countries, including the United States of America (Lord et al., 2020). ASD appears in males ten times more often than females (Zhang et al., 2020). The specific genetic markers for this difference are not clear. Many theories have been studied to decipher this difference. One is the female protective model, stating that the various genetic factors that combine to cause autism are less likely in females due to a lower rate of susceptibility to genetic inheritance. Another model is the extreme male brain theory which states that testosterone exposure in a fetus may lead to some genetic causes of autism. These are only two examples of varying theories, so it is still unclear what exactly the genetic difference is (Zhang et al., 2020). The immense increase in the prevalence of ASD cases since the 1960s (from 4 per 10,000 to 60 per 10,000 in 2005) seems to be due to a widening of the diagnostic criteria rather than an increase in the cases themselves. If the cases have, indeed, increased, it leads to the need for further research to determine the causes of ASD (Frith & Happe, 2005). This research could include the theory that underdiagnosis in females occurs due to differing diagnostic characteristics (Zhang et al., 2020).

### ***ASD in Children***

As mentioned above, ASD is usually diagnosed at an early age, between the ages of 3 and 5 (Haroon, 2019). Because the indicators of ASD are very similar to other developmental delays, intellectually and socially, it is often difficult to diagnose prior to observable social and cognitive

development; therefore, more research has been done on diagnosis of school-age children than younger children. The developmental delays in young children with ASD are similar to common developmental delays in the general population of children (Ventola et al., 2007). Specific communication deficits separate ASD from other developmental delays. These include using less conversational gestures (such as shaking or nodding the head for “yes” and “no”), more echolalia (repetition of the vocalizations of others), reduced response to verbal communication, and significant decrease in pretend play (Ventola et al., 2007). Different aspects of social development are significant to determining a child’s future sociability. With the decrease in social development aspects at school-age, it is helpful in diagnosing ASD as it combines the social and intellectual disabilities (Ventola et al., 2007).

Education is a major part of the early years of life for any child. Because success in school requires the combination of social and academic skills, there are many areas that may pose challenges for individuals with ASD. Group work and teamwork may be difficult, as comprehension of friendship forming is not always present. Organizational and rule-following aspects of a classroom setting may also be challenging for certain individuals (Haroon, 2019). Academically, studies show that reading skills are most impaired in terms of comprehension in those with ASD. Though there is still more research to be completed, ASD in children is far more researched than ASD in adults. It is significant for researchers to shift focus to adults as well, since it is one of the least common areas of study relating to ASD (Damiano et al., 2014).

### ***ASD in Adults***

Though it is rather uncommon and challenging, ASD is able to be diagnosed during adulthood. The symptoms of ASD in adults are similar to those of other psychological and personality disorders, including obsessive compulsive disorders and social anxiety disorders

(Fusar-Poli et al., 2017). The reason for diagnosis later in life could be due to the lack of social demands that showed the extent of symptom manifestation earlier in life. As more cases arise, researchers are creating diagnostic tools specific to adults (Fusar-Poli et al., 2017). Consistent with the large amount of research in children with ASD, the prevalence of ASD does not seem to change throughout the lifespan. If anything, prevalence seems to go down in adulthood due to misdiagnosis during childhood. Continuing into adulthood is the greater presence of men diagnosed with ASD over women (Tantam, 2014).

Most noticeable in adulthood, as well, are the physical and psychological effects of ASD. Though little research has been conducted, health records of patients with ASD show a higher level of mental and physical symptoms (Murphy et al., 2016) compared to neurotypical adults. In particular, adults with ASD show an increased rate of anxiety, depression, obsessive-compulsive disorder, sleeping problems, gastrointestinal problems, seizures, hypertension, and allergies. Contradictory to this extensive list of increased chances of medical difficulties is the lack of access to healthcare. This may be due to both lack of awareness of the physical aspects of ASD and inability to look past the overarching diagnosis of ASD to focus on other issues (Murphy et al., 2016).

As stated above, the area of ASD in adults is highly understudied. Though this disorder is lifelong, provision of services seems to nearly end post twenty-one years of age. This lack of services is most due to the elementary level of research in this area. Therefore, research on the needs and difficulties of adults with ASD is imperative. Some specific areas that should be at the forefront of research are service provision, health difficulties, transitional periods, and impact of aging (Murphy et al., 2016).

### ***Intervention for ASD***

Intervention is used to train specific cognitive processes to better the use in daily life. Some common areas of intervention include early intervention, behavioral intervention, and social processing intervention. Combining all the methods by intervening in children through social situation-focused behavioral mediation seems to be the most beneficial. The intervention options for ASD are extensive. Intervention is only made effective through the use of various factors, including caregiver participation and training, intensive sessions (multiple hours or sessions a week), early start, and the use of learned strategies in everyday life.

Because the most well-known aspect of ASD is the declined social interaction success, behavioral/social methods are well researched (Koegel et al., 2001). An example of a social intervention program is Social Perception Training (SPT). This is a program that is specifically helpful in learning environments by applying social competence skills through targeted cognitive insufficiency (Finne & Svartdal, 2017). The most common forms of intervention are behavioral. A behavioral method that has proven to be effective for early autism intervention is EIBI (Early and Intensive Behavioral Intervention). The distinctive characteristics of this approach are the vigorous, individual sessions, use of operant conditioning, and skill-based curriculum. The individual sessions are up to forty hours per week over the course of several years with specific focus on language curriculum. Operant conditioning includes the use of reinforcement and generalization. As EIBI has become more popular, there have been some alterations. These alterations have led to a lack of curriculum that contains all necessary elements. In order for EIBI to continue to be effective, more research needs to be done to find a conclusive curriculum that comprises all positive elements (Love et.al, 2001).

Generally, ASD has the most noticeable impact on social cognition and interpretation of spoken intentions. With adults being understudied, there are less reliable sources of diagnosis and intervention. As intervention and diagnosis strategies continue to evolve, social cognition in adults can gain more focus.

### **Social Perception**

Social interactions are influenced by the ability to infer what other people are thinking (Adolphs, 2009) via the process of adopting a ToM (Frith & Frith, 2001). ToM involves making assumptions about the mental state of others, including their beliefs, desires, and feelings (Abu-Akel, 2003). ToM is an important part of everyday social communication, and there are specific verbal and nonverbal cues that come into play when individuals communicate their intentions. Due to the complexity of interpersonal interactions, issues with ToM, processing emotions, and making sense of speaker intentions have been studied in populations associated with neurodevelopmental brain disorders, such as ASD or schizophrenia (Frith, 1989). The weakness of ToM causes the greatest difficulty in understanding of beliefs and perceptions of social situations in those with ASD (Brewer et al., 2017).

### ***Social Perception and Adults with ASD***

Different aspects of social interaction and perception have been previously researched. Zilbovicious et al. (2006) conducted a study of how the temporal lobe impacts the social interaction difficulties seen in ASD. In children, temporal lobe deficits are visible through lack of eye contact and inability to comprehend the mental states of others. Through the use of PET and MRI studies, it was shown that there are several superior temporal sulcus abnormalities in those with ASD. This leads to difficulty with social cognition, specifically in the areas of visual and



social perception. This suggests that connectivity to the social brain is decreased (Zilbovicius et al., 2006).

Falck-Ytter and von Hofsten (2011) conducted a comprehensive review of the different methods of looking at the social aspects of ASD. The avoidance of eye contact is a common finding in studies relating to social cognition; however, this review concludes that this is present but not always typical. The typicality is more apparent in adults than children. In this review, methods of research for this subject include videos and eye tracking (Falck-Ytter & von Hofsten, 2011). Important to our study is the use of videos.

Using a video database of social interactions, The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, & Rollins, 2002), Mathersul et al. (2013) examined ToM and empathy in high-functioning adults with ASDs. Their results show impairments in comprehending nonliteral intentions such as sarcasm. Participants also presented with lower cognitive and affective empathy when compared to a nonclinical control group. While this study has provided insight into the social perception skills in adults with ASD, the TASIT has some limitations, such as different lexical content in literal versus sarcastic scenes. The TASIT also uses a high demand forced-choice ToM task that correlates with emotion perception and social problem solving (McDonald et al., 2006) which might influence the performance of people with ASD and could limit real world implications.

In order to test the perception of complex social intentions such as sarcasm, teasing, and prosocial lies, Rothermich and Pell (2015) developed and validated a video database that allows for the investigation of social perception in both healthy adults and clinical populations. The Relational Inference in Social Communication (RISC) video database was inspired by the TASIT tool (McDonald, Flanagan, & Rollins, 2002) and also tests social perception and the

interpretation of speaker intentions. In comparison to the TASIT, the RISC offers (a) a significant number of trials needed for experiments using psycho- and neurolinguistic-experiments, and (b) the possibility of directly comparing the same lexical content with varying auditory and visual cues to literal and nonliteral conversations using a large inventory of video stimuli. The RISC database has been used as a tool for research (Giles et al., 2019; Rothermich & Pell, 2015; Rothermich et al., 2019) and it is planned to turn it into a clinical test battery to be able to assess and treat social pragmatic perception deficits in special populations in the future. The current study is part of the development of RISC as a clinical instrument.

Using videos from the RISC database, Jakobson et al. (2018) could not find a relationship between social broad autism phenotype (BAP) traits and greater difficulties in interpreting the speakers' intentions. Other researchers concluded that the relationship between social autism traits and social-cognitive skills in the general population can be weak (Davis et al., 2017), and that the influence of these traits on processing sarcasm and other intentions is task-specific (Sasson et al., 2012). Researchers have also assumed that, by using videos, they might have facilitated the identification of speaker intentions which allowed participants scoring high on social autism traits to be more successful than they would have been if tested with static stimuli (Jakobson et al., 2018). However, they did not test adults with a diagnosis of autism spectrum disorders. As the creation of this measure continues, other factors may contribute, such as the presence of empathy in the individual.

### ***Social Perception and Empathy***

Empathy is the understanding of the emotions of others. It is essential to everyday life and communication, allowing people to form connections with others (Harmsen, 2019). Recent studies have shown that empathy includes both an affective and cognitive component. Affective

is sharing the emotion, whereas cognitive is comprehending the emotion one feels (Mul et al., 2018). Many social elements combine to create empathy. In order to become empathetic, a person must be socially in control and use the basic social skills (Riggio et al., 1989). The study by Riggio et al. (1989), showed that expressive social skills are an indicator of one's empathy.

Research is consistent in the view that those with ASD have a decreased level of empathy. Greimel et al. (2010) looked at the neural mechanisms in relation to ASD and empathy. This fMRI study, as hypothesized, indicated a deficit in empathy in those with ASD. Mul et al. (2018) found the connection between empathy and ASD through a study combining empathy, interoception, and alexithymia. This study noted that there is a positive correlation between how well people understand the emotions of others and the amount of empathy felt. This also relates to how one understands his or her own feelings. It was shown that cognitive empathy was decreased in those with ASD, whereas affective empathy did not show a significant deficit (Mul et al., 2018).

The severity of the autism disorder may negatively correlate with the empathic abilities. Because ASD is a brain networking disorder, part of the disconnection is related to reduced emotional awareness about oneself and others, which has a direct impact on empathy. Underdevelopment of the understanding of nonverbal communication, such as facial expression, could also explain the misunderstanding of the emotions of others (Harmsen, 2019).

### **Current Study**

The significance and uniqueness of this study mostly fall into three categories. First, the RISC tool being used has ecological validity. It uses statements that are similar except for the conveying of nonverbal information and the situation. The participant must focus on the visual and auditory cues of the actors to determine the presence of sarcasm, teasing, prosocial lie, or

sincerity. Second, it was testing a range of intentions that are relevant in daily life. Finally, it was unique in the testing of adults, especially through the use of an online tool. The findings could lead to implications in clinical screening, assessment, and training.

The study objectives were to explore how ASD affects social-pragmatic processing and to explore how individual differences impact the perception of communicative intent. This research project was based on four basic research questions:

- (1). Is there a difference in speaker belief rating between the ASD group and the control group?
- (2). Is there a difference in speaker attitude rating between the ASD group and the control group?
- (3). Does empathy score correlate to speaker belief rating?
- (4). Does empathy score correlate to speaker attitude rating?

Speaker belief in the control and the ASD group was analyzed using a descriptive case study comparing two controls and two participants. The speaker's belief was a binary (yes/no) percent accuracy question setup, and the social perception of speaker attitude was a Likert scale (1-5) on friendliness. The intention was created as literal positive, literal negative (blunt), sarcasm, or teasing. Empathy was a descriptive analysis between Interpersonal Reactivity Index (IRI) scores with speaker belief and social impression.

## **Materials and Methods**

### **Participants**

Two adults with self-reported ASD and two healthy control participants from Rothermich et al. (2021) participated in the current study. The controls were matched with ASD participants based on gender and age (see Table 1 for participant demographics). As seen in Table 1, the

shortened Autism Quotient showed that the two participants scored consistent with what is expected in those with an ASD. The questionnaire explains that a score of 6 or higher could indicate an ASD, and a referral to a professional should be considered. Higher scores could indicate lower-functioning in accordance with the spectrum of Autism. Our participants showed scores of 9 and 10, which shows that they are very likely to be on the spectrum. The AQ was not completed for the controls.

**Table 1**

***Participant Demographics and AQ-10 Scores***

	Gender	Age	AQ
Subject 1	Not listed	34	10
Subject 2	Female	18	9
Control 1	Female	35	NA
Control 2	Female	19	NA

**Materials**

This study made use of two questionnaire measures: the shortened Autism Quotient and the Interpersonal Reactivity Index, followed by a yes/no and Likert scale question about videos from the RISC database.

***Autism Quotient***

We used the AQ-10 (shortened Autism Quotient; Allison et al., 2012) to ensure the participants are on the Autism spectrum. These ten questions are on a 4-point scale, “definitely agree” to “definitely disagree” (Appendix B). For example, “I often notice small sounds when

others do not.” (Allison et al., 2012). The validity of the AQ-10 has been confirmed in a study by Lundin and colleagues (2019) showing that it is a reliable measure of autistic traits.

### ***Interpersonal Reactivity Index***

Though there are different ways to measure empathy, this study focused on the Interpersonal Reactivity Index (IRI; Davis, 1983). This measurement assesses four dimensions of empathy: taking (cognitive empathy), empathetic concern (affective empathy), fantasy (identification with made up characters), and personal distress (reactivity to negative experiences of others; Riggio et al., 1989). We planned to correlate the IRI empathy scores with the accuracy in understanding speaker intentions (using videos from the RISC database). The IRI uses a 5-point scale, from “does not describe me” to “describes me very well” (Appendix C). For example, “I daydream and fantasize, with some regularity, about things that might happen to me” (Davis, 1983). The reliability and validity of the IRI has been validated previously (see Davis, 1994).

### ***RISC Database***

The present study evaluated how adults with ASD understand the social intention of others. The intent of the speaker was expressed using a literal positive, literal negative, sarcasm, or teasing response. The basic structure of the videos is a short clip (around 5 seconds) of two female actors conversing about five different overall scenes (see Table 2 for more details). Of the 600 total RISC database videos, 50 were selected for this study based on intention (literal positive, literal negative, sarcasm, teasing), actors (two females), and context (setting). The participants' task was to watch each video and answer two questions. The first question was to determine the intention of the speaker (e.g., “Did Anna want to try the cookies?”; answer options yes/no). The binary (yes/no) scale was used to assess the perception of speaker belief, revealing

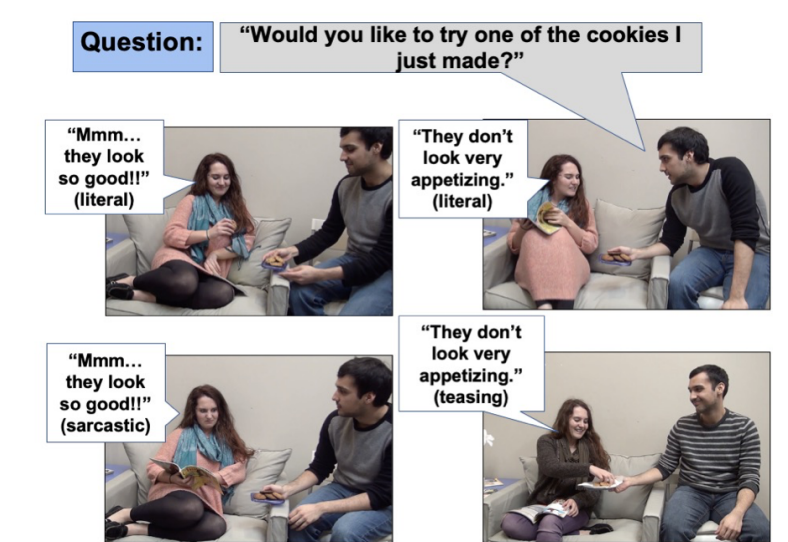
if the participant understood what the speaker meant. The second question was assessing the perception of speaker attitude and appropriateness of the statements/speaker in the form of a 5-point Likert scale on friendliness, ranging from “not at all friendly” to “very friendly.”

For example, in one of the scenarios, one of the actors spoke about a party and asked if the other actor in the scene thought it was a success. The responder (actor 2) replied with: a literal positive response (“Yeah, I had a great time!”); a sarcastic response (“Yeah, I had a great time!” coordinated with an appalled facial expression and/or tone or rolling eyes); a literal negative (blunt) response (“No, no one had fun.”); or a jocular (teasing) response (“No, no one had fun.” followed by laughing and smiling). Another example is presented in Figure 1.

Through multiple studies, the RISC database has become a dynamic, ecologically valid tool (e.g., Rothermich et al., 2021). The intentions presented are expressed through facial expressions, body language, tone, and spoken words. The actors/speakers in the videos use visual and auditory cues to communicate unstated implications. Some examples include the use of eye rolling to demonstrate a sarcastic response or laughter to show a teasing response.

**Figure 1**

*RISC Example Scenes*



**Table 2*****Different Scenes for RISC database***

Scene Topics	Leading Remark	Response
Painting	Do you like it?	<p>It's not really my taste. (Literal negative, teasing)</p> <p>Yes, it's just what this office needs. (Literal positive, sarcasm)</p>
Cookies	Would you like one of the cookies I just made?	<p>Honestly, they don't look very appetizing. (Literal negative, teasing)</p> <p>Hmmm they are so good. (Literal positive, sarcasm)</p>
Gifts	Do you like it?	<p>To tell you the truth, not really. (Literal negative, teasing)</p> <p>Yes, how did you know. (Literal positive, sarcasm)</p>
Gym	See, you can tell I've been working out...	<p>Really? You look the same to me. (Literal negative, teasing)</p> <p>I can see that. (Literal positive, sarcasm)</p>
Party	Do you think the party was a success?	<p>No, no one had fun. (Literal negative, teasing)</p> <p>Yeah, I had a great time. (Literal positive, sarcasm)</p>



## Procedure

Recruitment was completed via the Autism Society, Facebook groups, and personal references. The link for the Qualtrics questionnaire was posted or emailed and directly led participants to the study. (Recruitment script provided in Appendix A). No compensation was given to participants.

The research was delivered through an online questionnaire format called Qualtrics. Within this questionnaire, the participant completed the AQ-10 to assess presence on the Autism spectrum and the Interpersonal Reactivity Index (IRI) to assess empathy. After that they watched 50 videos taken from the RISC database (see item content in Table 2), they answered a question on speaker belief (Question 1) and friendliness (Question 2) after each video. Before starting the RISC task, participants were presented with an example video that introduced the actors, explained the concept, and completed a 4-item training with feedback on their responses (correct/incorrect).

Though we intended to run a mixed model statistics using R, the small sample size prevented the use of inferential statistics. Descriptive statistics were used to examine differences between the participants and their matched controls.

## Results

Results are presented based on the four research questions stated in the introduction.

### **RQ1: Comparing speaker belief rating between the ASD group and the control group**

Overall, all participants performed at ceiling when identifying the speaker belief (Was the speaker sincere yes/no) for sarcasm (100.0% for all participants, see Table 3 for details). When interpreting literal positive intentions, both groups performed similarly (mean ASD = 81.5% vs. mean controls = 85.0%). For literal negative (blunt) statements, adults with ASD scored lower

when compared to the control participants (mean ASD = 7.2% vs. mean controls = 95.0%).

Teasing statements were identified as insincere with lower accuracy in the ASD group (mean ASD = 25.0%) compared to the control group (mean controls = 100.0%).

**Table 3**

***Participant Accuracy (in %) by Condition***

	<b>Blunt</b>	<b>Literal positive</b>	<b>Sarcasm</b>	<b>Teasing</b>
Subject 1	0.0	80.0	100.0	50.0
Subject 2	14.3	83.3	100.0	0.0
Control 1	90.0	80.0	100.0	100.0
Control 2	100.0	90.0	100.0	100.0

**RQ2: Comparing speaker attitude rating between the ASD group and the control group**

Overall, there was not a noticeable difference in the friendliness scores when first looking at the chart (Table 4). Similar to speaker belief, the results for sarcasm were nearly identical for participants and controls (mean ASD= 1.6 vs mean controls = 1.4). The negative intentions (literal negative and teasing) also showed the greatest variability in responses (mean ASD = 3.6 vs mean controls = 2.7), with literal negative (blunt) statements having the greatest difference (mean ASD = 3.3 vs. mean controls = 2.3). Literal positive scores showed variability between all responses, including the two controls.

**Table 4*****Participant Ratings of Friendliness (Likert 1-5) by Condition***

	<b>Blunt</b>	<b>Literal positive</b>	<b>Sarcasm</b>	<b>Teasing</b>
Subject 1	3.9	4.6	1.6	4.6
Subject 2	2.7	4.8	1.6	3.3
Control 1	2.0	3.7	1.4	3.4
Control 2	2.5	4.5	1.4	3.0

**RQ3 and RQ4: Correlating the empathy score with speaker belief and attitude ratings**

Due to the small sample size we could not perform a correlation analysis. Table 5 shows the IRI empathy scores by participant and subscale. However, participants with ASD presented with lower cognitive empathy scores (mean ASD = 14.5 vs. mean controls = 19.8). No such marked differences were observed for affective empathy (mean ASD = 18.5 vs. mean controls = 20.5).

**Table 5*****IRI Subscale Scores***

	<b>Perspective Taking</b>	<b>Fantasy Scale</b>	<b>Empathic Concern</b>	<b>Personal Distress</b>
Subject 1	10.0	18.0	21.0	10.0
Subject 2	17.0	13.0	20.0	23.0
Control 1	22.0	15.0	28.0	26.0
Control 2	25.0	17.0	18.0	10.0

**Discussion**

Many studies have been conducted on understanding and using nonliteral language. Most of these studies use written materials (Pomareda et al., 2019; Dews & Winner, 1999), while few have used dynamic, multi-channel stimuli, such as videos, for their tasks (Philips et al., 2019; Mathersul et al., 2013). These studies' behavioral stimuli have assessed the convoluted nature of language in day-to-day social communication, as opposed to interactions specific to experimental or lab-based situations. We conducted a behavioral study using videos of interactions (RISC video database; Rothermich & Pell, 2015) to investigate the comprehension of literal and nonliteral speaker intentions. In addition, we used the Interpersonal Reactivity Index (IRI; Davis, 1983) to assess cognitive and affective empathy in participants.

The results of the speaker belief task showed that, while all participants seem to perform at ceiling when interpreting sarcasm, there were differences between the ASD group and the control group in the other speaker's intentions. People with ASD were less accurate identifying negative intentions, such teasing and blunt statements. This finding is consistent with results

from previous studies such as Rothermich et al. (2020, 2021) who showed lower accuracies for teasing statements especially in older adults and children. The greater difficulty with negative intentions could be due to a positivity bias that states a person is better able to understand positive emotions and situations (Williams et al., 2018). However, to my knowledge, a specific connection to those with ASD has not been well studied yet, but it should be further explored in future studies. Other reasons for misinterpreting social intentions in people with ASD could stem from the difficulties to decipher body language and facial expressions (e.g., Baron-Cohen et al., 2010), lack of knowledge about prosodic cues (e.g. Van Lancker, 1989), and trouble with integration between verbal and nonverbal language (e.g. McCleery et al., 2010). Specific training on social perception and nonverbal language could be helpful in growing these skills.

One method to test the processing of nonliteral language in adults with ASD further is to use eye tracking. An eye tracking experiment could reveal how people with ASD pay attention to the nonverbal cues (such as facial expressions or body language) compared to control subjects. Another option for future studies could be to compare audio-only and audio-visual versions of the RISC materials to test how participants with and without ASD process the two different conditions. It is possible that the video version is too complex and that participants are more accurate with an audio-only condition, but it could also be that they perform better when they also have the visual information available (see Iarocci et al., 2010).

The results of the speaker attitude (friendliness) task show a difference in negative intentions (blunt, teasing), just as the speaker belief task. The difference between the controls and participants, however, is not as noticeable in this task. One could assume that if participants misinterpret teasing statements as being sincere, they likely will judge it as less friendly. For example, Subject 2 seemed to have a lot of difficulty identifying teasing as insincere, and they

also judged teasing as less friendly on average when compared to Subject 1. However, Control 1 scored at ceiling for identifying teasing as insincere but still rated it as rather unfriendly. That means that even though they understand the positive intention of teasing, they do not seem to judge it as very friendly. This finding is consistent with previous studies using the RISC videos, showing that participants of all ages display great variability when judging the friendliness of teasing (Rothermich et al., 2021). This deficit in understanding teasing in our ASD group could have consequences for social relationships because they might misinterpret the intention of others. One source of the variability we observed could be due to individual differences in personality traits, such as empathy.

The IRI scores demonstrate that those with ASD have a more difficult time understanding what another person is feeling (cognitive empathy), rather than sharing the emotion (affective empathy). As Riggio et al. (1989) shows, presentation of empathy requires the understanding of basic social cognition. This idea is confirmed in our study as the limitations in negative social intention understanding were consistent with lower scores in cognitive empathy. The lower cognitive empathy scores are also consistent with studies on empathy in ASD such as Greimel et al. (2010) and Mul et al. (2018). The studies explain that the lower empathy levels may be due to diminished activation of the inferior frontal gyrus and fusiform gyrus, as well as deficits in emotional and social cognition (Greimel et al., 2010; Mul et al., 2018).

### **Limitations**

The biggest limitation for this study was lack of participation. Though there were many recruitment strategies (Facebook groups, personal contacts, Autism Society, etc.), the anticipated number of participants was not acquired. One reason could be that data collection occurred during the COVID-19 global pandemic. Due to the loss of jobs and wide-ranging health

concerns, extra financial strain and anxiety may have made potential participants less likely to take time to engage in a study. Because the study was conducted with an online format, participants may have been reluctant due to lack of a set time for evaluation, anxiety about privacy, and/or inability to understand the use of an online questionnaire. Finally, the length of the questionnaire (10 question Autism Quotient, 28 question IRI, and 50 videos followed by a speaker belief binary (yes/no) question and speaker attitude friendliness scale (1-5) and lack of compensation may have been typical study limitations that could be further evaluated for change in the future. Another limitation could be due to that an ASD diagnosis is less common in adults and the criteria have changed recently (Frith & Happe, 2005).

### **Future Directions**

In the future we plan to recruit more participants by offering an incentive and sharing the study more widely. With the COVID-19 pandemic becoming controlled and offering of compensation in the future, this seems like a very probable goal. In addition, the inclusion criteria stated that participants needed to be diagnosed with ASD. Though it did not require an official diagnosis, this may have been confusing to potential participants who have not been professionally diagnosed. If research for this continues, it can help to create diagnostic and treatment tools for adults with ASD, which is much needed.

### **Conclusion**

The findings of this study suggest that the difficulty with social meaning in adults with ASD lies in the interpretation of negative intentions. Cognitive empathy, as opposed to affective empathy, is the aspect that those with ASD seem to lack. Because cognitive empathy is in the understanding of others' emotions, lack of social perception of negative intentions may be connected. The inability to understand negative connotations by body language or facial

expressions could lead to misinterpretation of meaning. With further recruitment and research, we plan to transform this study into additional evidence that allows for the creation of diagnostic and intervention tools specifically for adults with ASD.



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## Appendix A

### Recruitment Script

Hi [insert name]

The Social Communication and Neuroscience Lab at East Carolina University has put together a research study about Autism Spectrum Disorder in adults. The Qualtrics online survey consists of two short surveys and 50 short videos followed by questions and takes about 30 minutes to complete. If you or someone you know qualifies for this study, it would be great if you could forward this message. More information about participant qualification is provided below. Thank you very much for helping us in our research.

Best wishes,

The SCONE Lab

Questions? Contact Kathrin Rothermich at 252-744-2329 or [rothermichk17@ecu.edu](mailto:rothermichk17@ecu.edu)

#### **Participants Needed for a Research Study Investigating Autism Spectrum Disorder and Social Pragmatics**

Participants Needed: Adults (18 years of age and older) with diagnosed Autism Spectrum Disorder.

What's expected? You will be asked to answer brief questionnaires and watch short videos of social interactions between two people. After watching each video, you will be asked a few questions regarding the two interaction partners.

Pay: No compensation

Time Commitment: approximately 30-40 minutes

Survey Link: [https://ecu.az1.qualtrics.com/jfe/form/SV\\_bKp8Kgkcx0Grvmt](https://ecu.az1.qualtrics.com/jfe/form/SV_bKp8Kgkcx0Grvmt)

Questions? Contact Kathrin Rothermich at 252-744-2329 or [rothermichk17@ecu.edu](mailto:rothermichk17@ecu.edu)



## Appendix B

### AQ-10

	Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
I often notice small sounds when others do not				
I usually concentrate more on the whole picture, rather than the small details				
I find it easy to do more than one thing at once				
If there is an interruption, I can switch back to what I was doing very quickly				
I find it easy to 'read between the lines' when someone is talking to me				
I know how to tell if someone listening to me is getting bored				
When I'm reading a story I find it difficult to work out the characters' intentions				
I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant etc.)				
I find it easy to work out what someone is thinking or feeling just by looking at their face				
I find it difficult to work out people's intentions				

## Appendix C

## IRI

	Does not describe me				Describes me very well
I daydream and fantasize, with some regularity, about things that might happen to me					
I often have tender, concerned feelings for people less fortunate than me					
I sometimes find it difficult to see things from the "other guy's" point of view.					
Sometimes I don't feel very sorry for other people when they are having problems.					
I really get involved with the feelings of the characters in a novel.					
In emergency situations, I feel apprehensive and ill-at-ease.					
I am usually objective when I watch a movie or play, and I don't often get completely caught up in it.					
I try to look at everybody's side of a disagreement before I make a decision.					
When I see someone being taken advantage of, I feel kind of protective towards them.					

I sometimes feel helpless when I am in the middle of a very emotional situation.					
I sometimes try to understand my friends better by imagining how things look from their perspective.					
Becoming extremely involved in a good book or movie is somewhat rare for me.					
When I see someone get hurt, I tend to remain calm.					
Other people's misfortunes do not usually disturb me a great deal.					
If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.					
After seeing a play or movie, I have felt as though I were one of the characters.					
Being in a tense emotional situation scares me.					
When I see someone being treated unfairly, I sometimes don't feel very much pity for them.					
I am usually pretty effective in dealing with emergencies.					
I am often quite touched by things that I see happen.					

I believe that there are two sides to every question and try to look at them both.					
I would describe myself as a pretty soft-hearted person.					
When I watch a good movie, I can very easily put myself in the place of a leading character.					
I tend to lose control during emergencies.					
When I'm upset at someone, I usually try to "put myself in his shoes" for a while.					
When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.					
When I see someone who badly needs help in an emergency, I go to pieces.					
Before criticizing somebody, I try to imagine how I would feel if I were in their place.					